



Uncertain Causal Reasoning

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Key Concepts:

Dynamic Bayesian Networks, uncertainty, temporal analysis, resource constraints, evidence accrual, and ensemble sampling.

Summary:

This project combines theoretical research in causal modeling and Bayesian networks with the development and refinement of a toolkit for applying causal modeling theory to the analysis of complex problems for the Air Force and DoD.

The theoretical and applied research in causal modeling and Bayesian networks is advancing the state of causal modeling in several ways, including the introduction of practical “causal synergy” modeling (Recursive Noisy OR), pioneering temporal models, modeling of resource constraints within causal models, developing a framework for evidence processing allowing for a much more sophisticated sensor model (impartial observations, false alarm rates, mis-detection rates), and finally developing a way to incorporate correlation information into Bayesian Networks.

The Causal Analysis Toolkit,

implemented in Java (JCAT) and recently updated to leverage the Eclipse Rich Client Platform, is a powerful modeling tool and a set of components (computational libraries) that can be used independently or integrated into other applications to analyze the uncertainty in complex systems. We provide a means

for conceptualizing and implementing an uncertain, temporal hypothesis that allows for a combination of subjective and observed knowledge to be incorporated within a single system model. The implementing technology is probability theory, the most accepted theory to describe complex systems with partial knowledge.

Benefits to Customers: Capability to model complex systems quickly (integrated weapon systems, situational assessments, stability analysis), where the end product is an interactive model to support decision making. This methodology has been used to study problems as widely varied as the kill chain, missile defense, and nuclear proliferation.

